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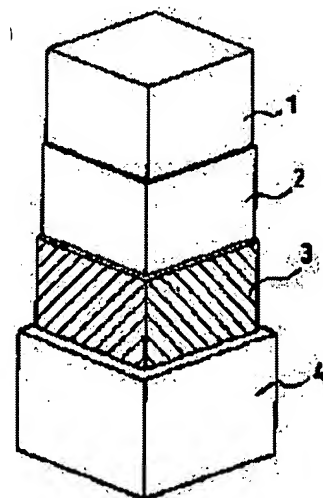
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## (54) REINFORCING METHOD AND REINFORCING BODY FOR CONCRETE STRUCTURE

### (57)Abstract:

**PROBLEM TO BE SOLVED:** To adjust thixotropy, improve impregnability, and improve reinforcing strength by mixing short aramid fiber, carbon fiber or glass fiber with an adhesive resin to impregnate the fiber sheet with the resin.

**SOLUTION:** A primer 2 is applied on the surface of a concrete structure 1 and a fiber sheet 3 such as carbon fiber, aramid fiber, etc., is impregnated with a resin adhesive and stuck on the structure to apply a surface finishing material 4 such as a resin painting material, a mortar spraying material, or a composite material of both materials. Moisture setting type, cold setting type, or heat setting type epoxy resin or photocuring radical polymerization resin is used as the impregnating adhesive resin. Aramid fiber, carbon fiber, or glass fiber having fiber length of 100-3,000  $\mu\text{m}$  is mixed as thixotropy- imparting agent. In this way, stable thixotropy in elapse of time and change of temperature can be adjusted and hence, impregnability into a fiber sheet is improved and reinforcing strength by the resin sheet can be improved.



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**DETAILED DESCRIPTION**

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**[Detailed Description of the Invention]****[0001]**

**[Field of the Invention]** This invention relates to the reinforcement object reinforced using the reinforcement method of construction with which the concrete structures, such as a building construction or a soil tree structure object, are reinforced with a fiber sheet, and its reinforcement method of construction. In more detail While having the thixotropy stabilized to time amount progress or a temperature change, the impregnating ability to a fiber sheet can adjust high sinking-in adhesion resin, and is related with the reinforcement method of construction and reinforcement object of the concrete structure which made it possible to obtain high resin reinforcement after construction moreover.

**[0002]**

**[Description of the Prior Art]** In recent years, reinforcement work which sticks a carbon fiber sheet and an aramid fiber sheet on a concrete front face by sinking-in adhesion resin, and is fixed for the purpose of existing reinforcement and repair of the concrete structure is performed frequently. It is one of the technical technical problems that the sinking-in adhesion resin used here reconciles fixable [ of the fiber sheet on the front face of concrete with whenever / tilt-angle / in which the many are epoxy resin system ingredients, and differ from raising the impregnating ability to a fiber sheet variously ]. Therefore, in order to adjust sinking-in adhesion resin to suitable physical properties, the compound aiming at the so-called thixotropy grant of an AMAIDO wax, fumed silica, etc. is chosen suitably.

**[0003]** However, by the sinking-in adhesion resin which blended the above-mentioned thixotropy grant agent, there was a problem that the thixotropy for reconciling impregnating ability and fixable was lost with time. Moreover, since it changed in the direction which is not desirable when the above-mentioned thixotropy grant agent was blended with sinking-in adhesion resin, it was difficult to receive constraint in combination of the sinking-in adhesion resin at the time of un-hardening, and to obtain a desired thixotropy. In addition, although mineral fiber system thixotropy grant agents, such as asbestos, were also used for in the past, it refrains from use from carcinogenic misgiving etc.

**[0004]**

**[Problem(s) to be Solved by the Invention]** While the purpose of this invention has the thixotropy stabilized to time amount progress or a temperature change, the impregnating ability to a fiber sheet can adjust high sinking-in adhesion resin, and is to offer the reinforcement method of construction and reinforcement object of the concrete structure which made it possible to obtain high resin reinforcement after construction moreover.

**[0005]**

**[Means for Solving the Problem]** The reinforcement method of construction of the concrete structure of this invention for attaining the above-mentioned purpose is characterized by blending at least one sort of thixotropy grant agents chosen as said sinking-in adhesion resin from aromatic polyamide fiber, the carbon fiber, and the glass fiber in the reinforcement method of construction which sticks a fiber sheet on the front face of the concrete structure by sinking-in adhesion resin, and is fixed to it.

**[0006]** Thus, while becoming possible to adjust the thixotropy stabilized to time amount progress or a temperature change by using at least one sort chosen from aromatic polyamide fiber, the carbon fiber, and the glass fiber as a thixotropy grant agent of sinking-in adhesion resin, it becomes possible to raise the impregnating ability to the fiber sheet of sinking-in adhesion resin. Moreover, by the reinforcement method of construction which used a fiber sheet and sinking-in adhesion resin, since the volume fraction of a fiber sheet is low and a resin part generally increases, it is in the inclination for the reinforcement as fiber strengthening resin to become low, but since the above-mentioned aromatic polyamide fiber, the carbon fiber, and the glass fiber have the reinforcement operation which it not only gives a thixotropy, but was excellent, it becomes possible to obtain high resin reinforcement after construction.

**[0007]** Furthermore, by the reinforcement method of construction which used a fiber sheet and sinking-in adhesion resin, although it is indispensable to perform fireproof processing or surface finish after resin hardening, since the sinking-in adhesion resin which blended the above-mentioned thixotropy grant agent forms rough skin-like irregularity

in a front face after hardening, it has the advantage that refractory material and a surface-finish cladding material tend to be established. Therefore, although it is working spraying silica sand etc. in the former before sinking-in adhesion resin hardens, it becomes possible to omit this.

[0008] Moreover, the reinforcement object of the concrete structure of this invention be characterize by to blend at least one sort of thixotropy grant agents chose as said sink - in adhesion resin from aromatic polyamide fiber, the carbon fiber, and the glass fiber in the reinforcement object which be the building construction or the soil tree structure object reinforced using the above-mentioned reinforcement method of construction, namely, stuck the fiber sheet on the front face of the concrete structure by sink - in adhesion resin, and be fixed to it.

[0009]

[Embodiment of the Invention] Hereafter, the configuration of this invention is explained to a detail with reference to an attached drawing. Drawing 1 illustrates the reinforcement object of the concrete structure which consists of an operation gestalt of this invention. In drawing, the fiber sheet on which the concrete structure and 2 were stuck on by the primer, and 1 stuck 3 by sinking-in adhesion resin, and 4 are surface-finish cladding materials. The fiber sheet 3 is stuck on the perimeter of this concrete structure 1 with sinking-in adhesion resin through the primer 2, and the surface-finish cladding material 4 is further formed in the outside of the fiber sheet 3.

[0010] The following procedures can perform the reinforcement method of construction of the concrete structure concerning this invention.

A. Surface treatment process (1) The front face of the surface treatment process existing concrete structure removes a fragile site and dirt by the suitable surface treatment method. Moreover, a projection etc. is removed about corners, such as a bridge pier. The level difference of the defect sections, such as an outcrop of the reinforcement with which repair was accepted to be the need by the preliminary survey, the remarkable partial-loss-of-area section, and a honeycomb, and a shuttering joint is repaired, and secures surface smoothness. A harmful crack is restored.

(2) In order to improve the adhesive property of the primer process existing concrete structure and a fiber sheet, apply a primer to the concrete front face which performed surface treatment.

(3) Finish evenly using unevenness adjustment material about the level difference of an unevenness adjustment process concrete side.

[0011] B. As a fiber sheet attachment process fiber sheet, a carbon fiber sheet and an aromatic polyamide fiber sheet can be used. Let the fiber sheet which lengthened and arranged these carbon fibers and aromatic polyamide fiber in an one direction or the two directions be the reinforcing materials of the concrete structure. The direction and number of sheets which stick a fiber sheet are suitably set up according to the reinforcement purpose. For example, in the case of an aromatic polyamide fiber sheet, twist around the perimeter of the concrete structure, it is made to use, and, in the case of a carbon fiber sheet, it is good to make it stick for the purpose of bending reinforcement as a rectangle sheet.

[0012] As sinking-in adhesion resin, the thing of a moisture hardening mold 1 liquid epoxy system, a room-temperature-setting mold 2 liquid epoxy system, a heat hardening mold epoxy system, or a photo-curing mold radical polymerization system can be used. These sinking-in adhesion resin is suitably chosen according to the reinforcement purpose or workability. As a thixotropy grant agent blended with sinking-in adhesion resin, at least one sort chosen from aromatic polyamide fiber (aramid fiber), the carbon fiber, and the glass fiber is used. These fiber is blended where the condition or it which the staple fiber fibrillated like aramid pulp, the milled fiber of a carbon fiber, and the milled fiber of a glass fiber is resembled. As for the die length of a staple fiber, more specifically, it is desirable to make it 100-3000 micrometers.

[0013] Since the above-mentioned thixotropy grant agent changes a comparatively long picture staple fiber into a fibrillation condition, it is not only possible to adjust the thixotropy stabilized to time amount progress or a temperature change, but it can raise the contact separation impregnating ability (phenomenon in which of leave a thixotropy grant agent and only the liquid component of resin is absorbed by the fiber bundle of a fiber sheet when a fiber sheet and sinking-in adhesion resin contact) to the fiber sheet of sinking-in adhesion resin. Moreover, the above-mentioned thixotropy grant agent has the reinforcement operation which was excellent since the modulus of elasticity in tension of fiber was high.

[0014] In addition, although a non-asbestos mineral fiber, asbestos, and polyolefine system pulp have effectiveness similar as a thixotropy grant agent, they have a problem at the other point. For example, good contact separation impregnating ability is obtained neither with a non-asbestos mineral fiber nor asbestos, but the resin reinforcement after construction becomes inadequate from polyolefine system pulp. However, using together the thixotropy grant agent chosen from aromatic polyamide fiber, the carbon fiber, and the glass fiber and other thixotropy grant agents does not bar.

[0015] The standard construction procedure and standard notes of a fiber sheet are shown below.

(1) Check that the primer is carrying out finger touch hardening.

(2) Cut a fiber sheet to the die length which was suitable for the attachment activity according to the design document.

(3) Fully stir sinking-in adhesion resin until it becomes homogeneity with a predetermined compounding ratio.

[0016] (4) Let 1 time of the amount of preparation of sinking-in adhesion resin be the amount which it finishes using within working life.

(5) Apply sinking-in adhesion resin to homogeneity by a paint roller etc. in a construction side (under coat).

(6) Push a fiber sheet against the spreading side of sinking-in adhesion resin, and stick, removing air bubbles in the direction of fiber orientation.

(7) Use the degassing roller for FRP, and a rubber spatula, and while removing an accumulator ball, fully infiltrate sinking-in adhesion resin into a fiber sheet.

[0017] (8) Apply sinking-in adhesion resin to homogeneity by a paint roller etc. again from the stuck fiber sheet, and sink in sinking-in adhesion resin completely (finishing).

(9) It is (5) when carrying out the laminating of the fiber sheet more than two-layer. - (8) An activity is repeated.

(10) By the time sinking-in adhesion resin results in an initial set, when an OAT will become 5 degrees C or less, perform suitable incubation treatment or use low-temperature-service sinking-in adhesion resin.

[0018] (11) The amount of the sinking-in adhesion resin used is based on the amount of the criterion used specified with the product. However, the amount of the criterion used is changed according to the class of an OAT or fiber sheet.

(12) When dew condensation occurs during construction, wipe with a waste etc. and make it dry.

(13) At the time of a rainfall and a strong wind, recuperate yourself with plastic sheeting etc. if needed so that neither storm sewage nor sand may adhere.

[0019] C. In order to improve the endurance of the reinforcement object which used the finishing process fiber sheet, perform surface-finish processing aiming at protection from light and protection from external force. The compound paint film which combined the coating with the coating ingredient of a resin system, the mortar blasting ingredient, and the blasting ingredient is used for a surface-finish cladding material. Selection of a surface-finish cladding material is performed in consideration of a site condition, an environmental condition, and also a scene. Moreover, it is made fire-proof-protection structure if needed. For example, in the case of an aramid fiber sheet, to make it the fire-proof-protection structure where sheet skin temperature does not exceed 220 degrees C is demanded.

[0020] Although the 1st effectiveness of this invention is being able to adjust the thixotropy stabilized to time amount progress or a temperature change by using at least one sort chosen from aromatic polyamide fiber, the carbon fiber, and the glass fiber as a thixotropy grant agent of sinking-in adhesion resin, it is not coming out so much, and the impregnating ability to the fiber sheet of sinking-in adhesion resin being high to coincidence, and unifying a thixotropy and impregnating ability on high level to it.

[0021] Here, it is judged based on the two following indexes that the impregnating ability to the fiber sheet of sinking-in adhesion resin is high. One can be checked in the phase which the resin into which sinking-in adhesion resin is the problem deeply [ how far ] a fiber sheet sinks in in end, and the fiber sheet was infiltrated hardened. another is the index of wet out rate, and when 100% of end sinking-in condition is acquired, it is decision whether to come out and to reach to 100%. In this invention, since not only the former sinking-in degree but the latter wet out rate is fully high, it contributes to time-necessary-for-completion compaction.

[0022] The 2nd effectiveness of this invention is using the pulp-like staple fiber of the same material as a fiber sheet as a thixotropy grant agent, and when it sees as a fiber sheet composite material, it is reinforcing the part of only the resin which is easy to be made since the volume fraction of a fiber sheet is low with a staple fiber, and losing the layer of only resin substantially macroscopically. It is important to reinforce this resin layer with the reinforcement method of construction which used the fiber sheet, since stress spreads from a concrete front face by interlaminar shear distortion to a fiber sheet through a sinking-in adhesion resin layer.

[0023] The 3rd effectiveness of this invention is the surface result after attachment immobilization of a fiber sheet. That is, fixing of refractory material or a surface-finish cladding material made indispensable with rough skin-like irregularity appearing in a resin hardening side is made easy. Consequently, although it is working spraying silica sand etc. in the former before sinking-in adhesion resin hardens, it becomes possible to omit this.

[0024]

[Example] The concrete structure was actually reinforced with the reinforcement method of construction of the following example and the examples 1 and 2 of a comparison.

example: -- the sinking-in adhesion resin of the contents shown in Table 1 by the usual approach on the concrete front face which performed sandur surface preparation and primer spreading -- an under coat -- carrying out -- subsequently -- an aramid fiber sheet (one direction aramid fiber sheet of a \*\*\*\* proof stress guarantee of 120t per AK-120made from FAIBEKKUSU: meter width of face) -- sticking -- subsequently -- degassing and sinking in -- carrying out -- resin -- a fiber sheet front face -- permeating -- a top -- \*\*\*\* -- it finished immediately, without waiting to come.

[0025] the example 1 of a comparison: the under coat of sandur surface preparation and the sink-in adhesion resin of the contents show in Table 1 on the concrete front face which performed primer spreading be carried out by the usual

approach, subsequently the aramid fiber sheet (one direction aramid fiber sheet of a \*\*\*\* proof stress guarantee of 120t per AK-120made from FAIBEKKUSU: meter width of face) be stuck, and subsequently it performed degassing and sink in, it stood by until the fiber sheet front face had be permeated by resin, and it finished after the check. After finishing, in order to improve fixing of finishing, silica sand was blown.

[0026] The example 2 of a comparison: It reinforced with the same procedure as an example except having changed the thixotropy grant agent blended with impregnating resin adhesives. About these examples and the examples 1 and 2 of a comparison, impregnating ability (degree), impregnating ability (rate), resin reinforcement, and a result appearance condition were evaluated, and the result was shown in Table 1. In Table 1, using BH mold viscometer, viscosity makes measurement temperature 20 degrees C, and measures the rotational speed of a rotor as 20rpm. A thixotropy index is the value which broke the viscosity measured by rotational-speed 2rpm by viscosity measured by rotational-speed 20rpm. Impregnating ability (degree) is 1.0 kg/m<sup>2</sup>. Waiting and the degree of sinking in were judged, resin moved by capillarity that resin hardened with the OAT of 20 degrees C, putting an aramid fiber sheet on the concrete side which applied sinking-in adhesion resin gently to the side front of a fiber sheet, and the case where all fiber was wrapped in was judged to be "sinking-in achievement." On the other hand, impregnating ability (rate) is expressed with time amount until sinking in is attained completely. Moreover, the sinking-in adhesion resin which blended the thixotropy grant agent is stiffened, and tensile strength is JIS. It measures using the No. 1 dumbbell of K7113. The reinforcement method of construction using a fiber sheet requires the tensile strength of 29 or more MPas as resin reinforcement.

[0027]

[Table 1]

表1

	粘度 (mPa・s)	サトロビ イデックス	含浸性 (度合い)	含浸性 (速度)	サトロビ 付与剤	樹脂強度 (MPa)	仕上がり 外観状態
実施例	8000	5.5	含浸達成	5分以内	アミドワ 1重量%	45	鯨肌で仕 上げ塗 りに好適
比較例1	8000	5.5	含浸達成	20～30分	フェムドシリ アイワックス 組合せ	35	ツルツル表面 上に珪砂 が定着
比較例2	8000	5.5	含浸達成	5分以内	ポリエチレン ワックス 1重量%	28	鯨肌で仕 上げ塗 りに好適

[0028] As shown in this table 1, the wet out rate to the reinforcement sheet of sinking-in adhesion resin was quick, the silica sand for moreover fixing finishing blew, and since it was \*\*\*\*\* needlessness, working capacity was excellent in the reinforcement method of construction of an example. Moreover, resin reinforcement was [ example / else ] very high at 45MPa(s). On the other hand, for this reason, by the reinforcement method of construction of the example 1 of a comparison, working capacity was too many [ the wet out rate to the reinforcement sheet of sinking-in adhesion resin is slow, and / the time and effort which the silica sand for fixing finishing blows ] inferior compared with the example. Moreover, although the reinforcement method of construction of the example 2 of a comparison was good in respect of workability, since polyolefine pulp was used as a thixotropy grant agent, resin reinforcement was inadequate.

[0029]

[Effect of the Invention] In according to this invention, sticking a fiber sheet on the front face of the concrete structure by sinking-in adhesion resin, and fixing, as explained above By having blended at least one sort of thixotropy grant agents chosen as sinking-in adhesion resin from aromatic polyamide fiber, the carbon fiber, and the glass fiber While being able to adjust the thixotropy stabilized to time amount progress or a temperature change, the impregnating ability to the fiber sheet of sinking-in adhesion resin can be raised, and, moreover, the reinforcement object of high resin reinforcement can be constituted after construction.

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**CLAIMS**

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**[Claim(s)]**

[Claim 1] The reinforcement method of construction of the concrete structure which blended at least one sort of thixotropy grant agents chosen as said sinking-in adhesion resin from aromatic polyamide fiber, the carbon fiber, and the glass fiber in the reinforcement method of construction which sticks a fiber sheet on the front face of the concrete structure by sinking-in adhesion resin, and is fixed to it.

[Claim 2] The reinforcement method of construction of the concrete structure according to claim 1 said whose sinking-in adhesion resin is any one sort of a moisture hardening mold 1 liquid epoxy system, a room-temperature-setting mold 2 liquid epoxy system, a heat hardening mold epoxy system, and the photo-curing mold radical polymerization system.

[Claim 3] The reinforcement object of the concrete structure which blended at least one sort of thixotropy grant agents chosen as said sinking-in adhesion resin from aromatic polyamide fiber, the carbon fiber, and the glass fiber in the reinforcement object which stuck the fiber sheet on the front face of the concrete structure by sinking-in adhesion resin, and was fixed to it.

[Claim 4] The reinforcement object of the concrete structure according to claim 3 said whose sinking-in adhesion resin is any one sort of a moisture hardening mold 1 liquid epoxy system, a room-temperature-setting mold 2 liquid epoxy system, a heat hardening mold epoxy system, and the photo-curing mold radical polymerization system.

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